The 1987 Newfoundland Oil Spill Recovery Experiment

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Objectives: To evaluate existing oil spill containment and recovery technology and procedures, and to verify a nonpolluting performance evaluation protocol for offshore oil spill containment booms.

A joint Canadian-United States exercise involving the intentional oil spill of 18,000 U.S. gallons was conducted on September 24, 1987, off St. John's Newfoundland to evaluate the containment and recovery capability of three booms and skimmers. The spill also provided an opportunity to verify a nonpolluting performance evaluation procedure for offshore oil containment booms. The spill was conducted approximately 25 nautical miles east of St. John's. The ocean dumping permit required south-southwest currents and westerly winds (to minimize the chance of shoreline contact), water depths of at least 100 meters, a site at least 25 nautical miles from shore, and an area to be within 2 to 3 hours steaming from St. John's. The center of the area selected was 47 degrees, 40 minutes North latitude, and 52 degrees, 03 minutes West longitude.

A crude oil similar to typical high wax Grand Banks crude was unavailable. Brent crude from the North Sea was obtained and treated by adding 1 percent slack wax, by volume, to yield an oil of similar physical properties. The modified oil had a density of 839.8 kg/m^3 and a viscosity of 20 m Pas at 12 degrees C (Ross, 1987a).

Meteorological conditions were recorded on the Canadian Coast Guard (CCG) Cutter Grenfell at 15 minute intervals. These included corrected wind velocities and air and water temperatures. A wave rider buoy was deployed at the test site but failed to function during the exercise. Consequently, sea conditions were estimated, with reasonable agreement, by various trained observers.

The test plan called for the sequential deployment of three booms as follows: A 250 meter length of the specially instrumented Oil and Hazardous Material Simulated Environmental Test Tank (OHMSETT) boom would be deployed in normal catenary. Approximately 18,000 gallons of treated Brent crude would be spilled by the command/recovery ship Terra Nova Sea into the catenary. The oil would be held in the boom for approximately 1 hour while boom freeboard and draft data and visual observations of oil retention were recorded. During this period, 200 meters of the Canadian Coast Guard's RO-BOOM would be deployed behind the OHMSETT boom. The tow speed would be increased to "significant loss" speed (0.5-1.0 knot), a tow velocity which would permit oil to circulate under and over the boom. One end of the boom would then be released and the oil discharged into the RO-BOOM. Oil would be held in the RO-BOOM for approximately 1 hour while the oil retention capabilities were observed. The St. John's Coast Guard Vikoma Ocean Pack boom, 400 meters long, would be deployed behind the RO-BOOM during the observation period. The last procedure would require significant loss tow speeds to be repeated with the RO-BOOM, and the oil released into the Vikoma.

Oil would be retained in the Vikoma for approximately 1 hour. The Terra Nova Sea would then commence skimmer evaluations. Two skimmers, the Framo ACW400 and an innovative Coast Guard Heavy Oil Skimmer (HOS), would be evaluated for 20 minutes each. The remaining contained oil would be recovered by the skimmer exhibiting the better performance (Ross, 1987b).

The intent of the OHMSETT boom deployment was to verify the hypothesis that the ability of a boom to contain oil is correlated with its ability to sea keep or comply with wave-induced surface motion. If this hypothesis could be verified and quantified, future performance evaluations of offshore containment booms could be restricted to measuring seakeeping capabilities in a wide range of sea states.

No further spills of the 20,000 gallon size of light and heavy oils would, therefore, be required to evaluate each type of boom. Ocean dumping permits are difficult to obtain and intentional oil spill exercises of this magnitude approach the million dollar funding level. In addition, intentional spills also constitute a risk of potential damage to the immediate environment. Clearly, a cost-effective and nonpolluting evaluation procedure for offshore equipment is necessary to develop a predictive capability for the performance of offshore response equipment. Wind conditions desired were sea state 2 to 4 (winds 10 to 20 knots, 1 to 4 foot waves).

The ships and smaller vessels sailed at 6:00 a.m. and proceeded to a location 5.5 miles off Torbay Point. The CCG Grenfell then deployed the OHMSETT boom and passed one end to the CCG Cutter 212 which took the boom in tow. The CCG Cuttter 206 then attempted to pick up the trailing end of the boom, a job which took 45 minutes. As soon as the 206 had the end of the boom secured, the two cutters attempted to tow the boom, in a "U" configuration, into a position astern of the Terra Nova Sea. This resulted in the OHMSETT boom immediately beginning to twist on itself, and 1 hour was lost in straightening the boom. Eventually the boom was positioned relative to the Terra Nova Sea and simulated discharge of the oil was carried out. Data collection, without oil, for almost 1 hour followed.

While the OHMSETT boom was being deployed and positioned, the RO-BOOM was deployed from the CCG Sir Humphrey Gilbert and passed to CCG Cutter 214. This procedure took almost 2 hours, and the RO-BOOM was rapidly positioned with respect to the OHMSETT boom because both the Cutter 214 and a Boston Whaler were able to tow the boom at speeds of 5 knots.

With the RO-BOOM in position, the Cutters 212 and 206 commenced to maneuver, presumably to form a "J". The Cutter 206 then snagged the OHMSETT cable in her screws and cut it, disabling herself. This resulted in delay of the exercise while the cable was freed, and because Cutter 214 and an assist boat (a Boston Whaler) were now approaching closely, the Cutter 212 took the boom and Cutter 206 in tow and cleared the area so as not to impede the exercise.

During the period in which the RO-BOOM was being deployed, the CCG Grenfell deployed the Vikoma boom. Once the simulated oil release was over, the Terra Nova Sea took the other end of the boom and the vessels formed a catenary. After holding position relative to the RO-BOOM for a short period, the ships formed a "J" with the boom and practiced deploying the skimmers.

All ships returned to harbor by 5:00 p.m.

Several meetings of the senior people involved in the exercise occurred between September 21 and September 23, 1987. It was decided to remove Cutter 206 from the exercise. The Boston Whaler was able to tow and hold the boom in sea state 1, but it was recognized that this would be difficult with oil in the desired weather. The Newfoundland Fisheries department had provided a vessel, the Bernier, and it was decided to use her and a second chartered offshore supply vessel (OSV) to tow the RO-BOOM.

Concern was expressed that the weather might, surprisingly, be too calm on September 24, the day which looked best for the actual trial. It was, therefore, decided to interchange the OHMSETT and RO-BOOMs to take advantage of the higher winds and waves expected later in the day.

The long time required to deploy the RO-BOOM from the Sir Humphrey Gilbert led to a decision to deploy that boom from the second OSV, the Triumph Sea. Repairs were carried out on the OHMSETT boom instrumented cabling, and the boom with instrumentation was functional by 5:00 p.m. on September 23.

Since the Terra Nova Sea had oil recovery tanks on board, it was decided to dispense with the dumb barge and to release the oil directly from that OSV.

The Triumph Sea and the Bernier sailed at 3:00 a.m. All other vessels sailed at 4:00 a.m., and everyone was on station by 6:45 a.m. The Triumph Sea commenced deployment of the RO-BOOM enroute, and by 7:30 a.m. the boom was ready to receive oil. Once the OHMSETT boom was deployed, at 8:15 a.m., the oil was pumped into the RO-BOOM under supervision from the helicopter and a small boat.

All oil was in the boom by 9:00 a.m.

It was decided to give the news media a chance to view the test from the air and this was done from 9:00 a.m. to 10:00 a.m. During this period, the Cutters 212 and 214 attempted to pull the OHMSETT

boom into proper position in the wake of the RO-BOOM and to keep it there. Every attempt to move the boom, in a catenary configuration, in the 15 knot winds blowing at the time resulted in the boom twisting. As a result the OHMSETT boom fell progressively further behind the RO-BOOM.

At 10:30 a.m. the oil in the end of the pocket of the RO-BOOM was 30 cm thick, the wind was 15 knots, and some splash-over and significant drainage under the boom were occurring. The vessels, therefore, formed a "J" and released one end of the boom to allow the oil to flow into the OHMSETT boom. The OHMSETT boom was approximately 1 km astern, and the vessels were having trouble towing that boom in a catenary without it twisting. It was, therefore, decided to direct the cutters towing the OHMSETT boom to the oil by helicopter, keeping the boom in a straight tow. After 20 minutes, the cutters were adjacent to the thick oil, and, after a further 20 minutes, approximately 80 percent of the thick oil was in the OHMSETT boom. The remaining 20 percent was contained in the Vikoma boom. Data collection on the OHMSETT boom started as soon as the oil was captured and continued for 56 minutes. The cutters then stopped across the path of the vessels towing the Vikoma boom and released one end of their boom. The oil spilled into the Vikoma boom catenary, and one cutter trailed the OHMSETT boom at the throat of the catenary allowing the waves to wash the oil into the Vikoma boom.

The Grenfell and Terra Nova Sea towed the oil filled Vikoma boom for approximately 1 hour. During this time, the wind freshened to 15 knots to 20 knots. The boom was moving over 1.1 knots relative to the sea, and some oil was lost (approximately 3 mm thick). The Grenfell then attempted to move ahead to form the "J" for the skimmers. Not being very maneuverable, she quickly reached 3.4 knots and the oil was lost.

With the oil now lost, the weather abated slightly. The RO-BOOM was still streaming astern of the Triumph Sea so it was decided that she and the Bernier would form the boom into a catenary and attempt to recover the oil by steaming downwind. The helicopter was lost to the exercise for approximately 1 hour at this time. In the interim a small boat was used to guide the tow vessels into the heaviest portions of the slick. When the helicopter returned, it was able to determine from its vantage point that the vessels with the RO-BOOM were adjacent to some of the oil though they were unable to see it. They were, therefore, directed from the air and small boat, and managed to collect 80 to 90 percent of the thick oil which was on the surface at the time.

Oil was successfully contained and recovery was attempted using the three skimmers on board the recovery-command vessel. The first skimmer, HOS, was deployed and no measurable recovery was observed. The oil used was modified by adding petroleum wax so that it would resemble a typical Grand Banks crude oil. This type of oil is uncharacteristic of most crudes in that it possesses low adhesive properties. Therefore, oleophilic skimmers, which depend upon the adhesive nature of the recovered oil, do not perform well with high paraffin-based oils. This was again proven with the oleophilic HOS skimmer. The skimmer was recovered after several trained observers were satisfied that it had sufficient evaluation time in the contained slick. Problems with the inability of the support arms used to suspend both the HOS and Framo skimmers and adjust to the roll of the vessel in the short period waves, resulted in both skimmers being frequently submerged so that oil and water were washed into their sumps.

The second skimmer, the Framo ACW-400, was deployed. The overall rate of oil recovery was 60 gallons per minute, there being unknown amounts of oil recovery because of frequent partial submergence.

At this point, it was decided by the on-scene commander that skimmer evaluation was complete. Additional measures were needed to ensure recovery of the remaining contained oil because the weather was deteriorating and the night approaching. Accordingly, approximately 7 pounds of the visco-elastic agent "Elastol" were spread from an 8 ounce styrofoam coffee cup into the estimated 7,400 gallons of oil and oil-water emulsion in the containment boom. Elastol was added because previous research supported by the Minerals Management Service and Environment Canada had shown that the elastic and adhesive properties of the oil could be increased by addition of the agent, thus making the oil more readily capturable with these types of skimmers. The Framo ACW-400 was retrieved from the slick as the Elastol was added, and because of rough weather and the lateness of the day, the skimmer was not redeployed.

The weir-type skimmer, Pharos Marine GT-185, was deployed into the treated slick; it recovered near capacity rates of 85 gallons per minute of oil and oil emulsion, there being no free water. This recovery rate was higher than anticipated and may have been even higher if the oil had been untreated. Treatment significantly increased the viscosity of the oil. The skimmer was removed from the slick.

The HOS skimmer was redeployed and yielded a recovery rate of 50 gallons per minute even though a portion of the oleophilic fabric on one of its two drums was damaged. Debris was collected at this time in the venturi system used to measure recovery fluid flow rates. The debris may have contributed to the subsequent failure of the HOS skimmer return hose. No flow-rate measurements were taken before the failure. Visual observations on the amount of oil adhering to the oleophilic fabric of the HOS skimmer indicated that recovery rates were significantly increased by the addition of Elastol.

Operations were suspended because of the increasing sea states and advancing darkness.

An overflight of the area by helicopter was carried out during the skimming operation revealing a sheen approximately 2.5 by 0.5 nautical miles with 3 patches of brown oil. It is estimated that no more than 260 gallons of oil remained in the thick patches. A further flight 18 hours later showed that only small brown patches and sheen remained, and this was rapidly dispersing.

Conclusions

- Thorough proficiency in the use of recovery equipment is essential for effective operations. Routine practice is required to achieve this degree of readiness.
- Large volumes of oil (at least 20,000 U.S. gallons and preferably 80,000 gallons) are necessary to realistically evaluate performance of offshore response equipment.
- The use of helicopters to direct the placement of tow vessels and the use of small vessels to monitor and advise on boom conditions are essential to maximize the efficiency of conventional recovery operations.
- Accurate measurements of the meteorological and sea conditions are necessary for accurate analysis of the evaluations.
- The requirements for slow-speed towing and maneuvering of large containment booms necessitate the use of vessels with variable pitch propellers, bow thrusters, and good seamanship.
- It is not possible to form a recovery configuration using two vessels, towing upwind. A third vessel is necessary for recovery of the oil in the catenary.
- Upwind collection proved impossible when winds approached 15 knots. This is consistent with many past observations for containment operations conducted upwind.
- The upper meteorological and sea state limits for downwind containment and recovery were not reached during this test.
- Contained oil will be lost if shipboard discharges such as cooling water impinge upon the slick during recovery operations.
- Tankage should be available for recovery of several times as much fluid as discharged to account for the oil and water emulsions and free water recovered.
- Recovery of high wax oils similar to Newfoundland crudes in 10 degrees C water is significantly enhanced by the use of Elastol.

References

Ross, S.L., (1987a), Offshore Testing of Booms and Skimmers: Environmental Research Limited, Ottawa, Ontario.

Ross, S.L., (1987b), Test Protocol for Offshore Boom Trials: Environmental Research Limited, Ottawa, Ontario.